

AERMOD & CALPUFF



EPA's Newly Proposed Regulatory
Air Dispersion Models

Outline

- ✧ Regulatory Niche
- ✧ Developmental Approach
- ✧ Model Overview
- ✧ Technology Transfer
- ✧ R&D Needs

Regulatory Niche

✿ AERMOD

- Replacement for ISC3
- Near-field impacts (within 50 km)
- Sources located in either simple or complex terrain
- Non-reactive pollutants
- Permitting and area-wide planning (SIP's)
- Air toxics sources (fenceline & long term exposure)

Model's Regulatory Niche (cont.)

✿ CALPUFF

- Long Range Transport (beyond 50 km)
 - Impacts from new sources on National Parks: e.g., visibility impairment, acid deposition, etc.
 - Large modeling domains
- Complex Winds: Non-uniform wind field is a controlling feature of the analysis
- Multi-media risk assessment

Development Approach

✿ AERMOD

- AERMIC Committee (voluntary): Both research & regulatory application interests represented from beginning
- Design criteria
 - **Up-to-date science** - replacement for ISC
 - **Simple** - essential physical processes
 - **Robust** - in estimating (regulatory) design concentrations
 - **Easily implemented** - primary users are the regulatory community
 - **Can Evolve** - Easily accommodate modifications

Development Approach (cont.)

✿ AERMOD (cont.)

- Two phased evaluation
 - Phase I: Development (5 data bases)
 - Phase II: Evaluation (5 data bases)
- Evaluation tests
 - Residual plots (C_p/C_o vs. x , z_i , u , etc.)
 - Quantile-Quantile (Q-Q) plots - Compare ranked distributions
 - Cox-Tikvart (robust highest concentration)
- Met degradation analysis
- Sensitivity and consequence analyses

Development Approach (cont.)

✿ CALPUFF

- Initial development - Earth Tech under contract to CA
- Many subsequent contracts (variety of organizations) have added to its development
- Public Domain - With each advance Earth Tech makes model available to the community at large
- Evaluations: (5 LRT & 3 Near-field data sets)
- Evaluation tests
 - Match cross-wind Conc. Dist. & arc max)
 - Q-Q plots
- Comparison w/ISC3

AERMOD Overview

- ✂ Contains all ISC features except deposition
- ✂ Steady-state plume model
 - Gaussian for the SBL & lateral CBL
 - pdf (bi-gaussian) for the vertical CBL
- ✂ Meteorology used by AERMOD
 - Profiles of wind, temperature & turbulence
 - Minimum needed to estimate profiles:
 - One NWS surface and upper-air site
 - surface roughness, Bowen ratio & Albedo
 - Will combine all additional observations with estimates to produce combined profiles
 - Vertical inhomogeneity is considered

AERMOD Overview (cont.)

✿ All terrain model

- Considers the dividing streamline concept in determining the degree of influence on the plume at each receptor.

✿ Dispersion

- Plume spread statistics are estimated from turbulence profiles
- Special treatment of dispersion for near-surface releases

AERMOD Overview (cont.)

✿ Convective Boundary Layer

- Delayed mix lid reflection (residual buoyancy)
- Plume penetration into stable layer & reentry

✿ Stable Boundary Layer

- Vertical mixing is limited
- Includes meander effects

✿ Urban nocturnal boundary layer

- Modeled using:
 - Nighttime convective velocity scale
 - Nighttime mixing layer
- Based on urban-rural temp difference

CALPUFF Overview

☞ Integrated Modeling System

- Pre & post-processors
 - Geophysical data
 - Precipitation
 - Surface and upper air met
 - Visibility and deposition flux calculations
- Diagnostic met model (CALMET)
- Non-steady-state Lagrangian puff model (CALPUFF)

CALPUFF Overview (cont.)

✿ Emissions

- Non-steady-state emissions
- Emission model for controlled burns

✿ Dispersion

- 3 primary options: observed or estimated turb, PG, McElory-Pooler
- Overwater and coastal effects

✿ Subgrid scale complex terrain

- Flow distortion & enhanced dispersion
- Sidewall interactions

CALPUFF Overview (cont.)

- ✂ Deposition - dry & wet / gas and particle
- ✂ S & N chemistry - highly parameterized using simple linear approximations
- ✂ Meteorology (CALMET)
 - Input:
 - Multiple surface, upper air & precip stations
 - Land use data
 - Can use prognostic results as pseudo-soundings (MM5)
 - Produces 3D gridded fields of u,v,w, temp, turbulence & mixing heights

Technology Transfer

- ✿ Both models are available on EPA's Technology Transfer Network - SCRAM site (<http://www.epa.gov/ttn/scram/>)
- ✿ Training Needs: regulatory community needs to be transitioned from PGT understanding of dispersion to current state-of-the-science.
- ✿ Training courses
 - CALPUFF - provided by Earth Tech for fee
 - AERMOD - provided by AERMIC as available

Development Needs

❧ AERMOD

- Deposition
- Downwash
- Urban boundary layer improvements

❧ CALPUFF

- Precip/non-precip cloud interactions
- Aqueous phase chemistry module
- Terrain enhancement of precipitation
- Nested grid option